

A New Species of *Narraga* Walker (Geometridae, Ennominae) from Georgia, with Biological Notes

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Abstract. *Narraga georgiana*, n.sp., is described from Ohoopée Dunes, Tattnall Co., GA, and contrasted to other known N. American *Narraga* species. *N. georgiana* is a day-flier, and the only member of the genus known to occur east of the Mississippi River. The food plant is shrub goldenrod, *Chrysoma pauciflosculosa* (Michx.) Greene (Compositae). Immature stages, habitat and habits of *N. georgiana* are described.

Introduction

On April 11, 1981, the last two coauthors were collecting butterflies together in the Ohoopée Dunes, which straddle the Candler and Tattnall county line midway between Macon and Savannah, Georgia. They noticed a small, erratically flying moth crossing the dirt road they were following, and collected 9 specimens within 30 minutes. Unable to identify the moth beyond the family level, Finkelstein sent specimens to Covell for determination. Based on the brown color, bipectinate antennae, and striking pattern of the hindwing underside, the moths were identified as members of the genus *Narraga* Walker, 1862 (= *Fernaldella* Hulst, 1896). Comparison of superficial and genitalic features of a lengthy series of the Georgia moth with specimens of other *Narraga* material from Texas and westward has convinced us that the former represents a new species, which we name and describe as follows:

Narraga georgiana Covell, Finkelstein & Towers, new species

Description: **Head** with vertex mixed dark brown and ochre. Front bulging, clothed with rough scales, mixed dark brown, ochre, and whitish. Palpi project forward; segments 1-2 white with a few brown scales; apical segment dark brown. Antenna broadly bipectinate in male, narrowly so in female; shaft and pectinations clothed dorsally with dark brown and ochre to whitish scales, appearing peppered; underside of shaft and pectinations black, unscaled.

Thorax dark brown dorsally with some scattered ochre to whitish scales; patagia brown with conspicuous whitish outer basal patch. Underside mostly whitish with some brown scales. Legs mostly mixed dark brown and ochre, with extensive whitish scaling on outer side of coxa and femur. Hind tibia bears 2 spurs in both sexes.

Abdomen dark brown, peppered with ochre; segments 1-7 banded apically with mixed ochre and white, the bands interrupted middorsally with ground color.

Wings broad, shaped as in other *Narraga* species (Figs. 1-4). Ground color evenly dark chocolate brown, fading to paler brown in older specimens. Forewings above unmarked except as follows: variable diffuse ochre scaling in basal area along costa, diminishing inward in density; diffuse ochre patch along costa at top of median area; sharp ochre bar, slightly curved, extending inward from costa near apex; and ochre checkering in fringe. Hindwings above uniform dark chocolate brown, including fringe.

Forewings beneath have markings of upperside repeated, but apical area and upper terminal area dominantly ochre. Curved bar near apex silvery pale yellowish white, edged with brown. Silvery yellowish white terminal bars, edged with dark brown, occupy spaces between veins R_4 and R_5 , R_5 and M_1 , and M_1 and M_2 ; traces of narrower bars occur between M_2 and M_3 and M_3 and Cu_1 in some specimens. Pale checkering in fringe also more silvery yellowish white than above.

Hindwings beneath dominantly ochre, the dark chocolate brown restricted to variably wide edging around silvery yellowish white spots and lines; brown shading usually widest toward base. Basal half of wing usually has 5 variably shaped silvery yellowish white markings, basad of median line: long basal costal edging, followed by broader spot near top of median line; trapezoidal basal bar followed by small subtriangular spot in cell; and large spot near inner margin, sometimes extending to base, though mixed with ochre and dark brown. Median line irregular and variable, usually with bulges just above middle, and again at inner margin; line divided between bulges into 2 separate sections in some specimens examined; and several specimens seem to have line broken into 3 parts. Usually 7 rounded dashes between veins toward outer margin, although the largest (third from apex) occupies much of the space between M_1 and M_3 , crossing vein M_2 . Fringe checkered ochre and brown, with small white patches opposite some of the terminal white dashes.

Wingspan: males, 1.9-2.1 cm; females, 2.3-2.6 cm.

Male length: males, 1-1.2 cm; females 1-1.3 cm.

Male genitalia (Fig. 9) small; 1.1-1.3 mm from tip of uncus to tip of vinculum. Tegumen thin, circular. Uncus broad at base, narrowing to ventrally directed point. Juxta broad, bilobed, membranous. Valves deeply cleft; lobed valvula only slightly indented at about midpoint of ventral margin, just beyond 2-3 small, setose tubercles; sacculus very broad with slightly ragged margins, ending in rounded point. Aedoeagus very broad and membranous at anterior end, narrowing to a curved point; dorso-distal end developed into a rounded tooth (carina). Usually 2 small, narrow, pointed cornuti in the vesica.

Female genitalia (Fig. 11) about 3.2-3.5 mm in length. Sterigma membranous, posterior half slightly narrower than anterior half; rounded notch in middle of posterior margin, with slight projections of margin on each side of notch. Ostium rounded, leading into short, moderately sclerotized ductus bursae which narrows slightly as it blends into curved neck of corpus bursae. Corpus bursae entirely membranous, simple, with ductus seminalis entering it near juncture with ductus bursae. A single, very small, thorn-like signum present at about midpoint of corpus bursae.

Types: Holotype male, Ohoopee Dunes, Tattnall Co., Georgia, Sept. 11, 1981, leg. I. L. Finkelstein (C. V. Covell, Jr. genitalia preparation no. 1,112). Allotype

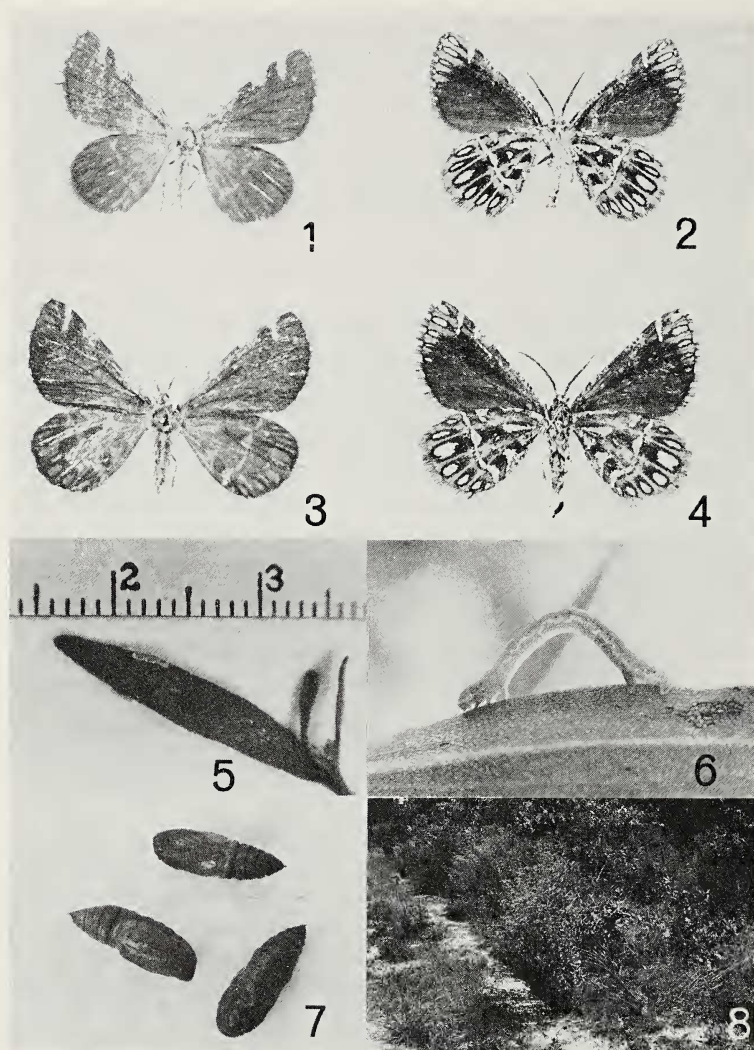
female, same locality and collector, Sept. 6, 1981. Both in American Museum of Natural History, New York City. Paratypes: 17 males and 10 females, all from the type locality, Apr. 11, 1981 (4 males), Sept. 6, 1981 (7 males, 6 females), Sept. 11, 1981 (6 males, 3 females); and Apr. 13, 1982 (1 female). Paratypes in the Carnegie Museum, Pittsburgh; Florida Collection of Arthropods, Gainesville; University of Georgia, Athens; Natural History Museum of Los Angeles Co., Calif.; U.S. National Museum of Natural History, Washington, D.C.; and collections of the authors. Preserved ova, larvae, and pupae in U.S. National Museum.

Discussion

Ferguson in Hodges *et al.* (1983) applied *Narraga* Walker 1862 to 2 North American species formerly considered to be in *Fernaldella* Hulst, 1896. The type of *Narraga* is *Geometra cebraria* Huebner (a synonym of *Phalaena fasciolaria* Hufnagel) from Europe; that of *Fernaldella* is *finetaria* Grote & Robinson, 1870, from Texas. The other included species is *stalachtaria* Strecker, 1878. In order to establish the identity of *finetaria*, a search was made for the 11 specimens mentioned in the original description, all of which were sent to the authors by Belfrage, who collected them in Texas in August. Only one specimen was located that might be one of these syntypes: a male from the New York State Museum in Albany. Labels on this specimen include one with the number "4085" and another in what seems to be Grote's handwriting (in the opinion of Dr. Timothy McCabe), stating "Fidonia finetaria Gr.-Rob., Texas, ♂." Since it is not labelled "Type," it may or may not be part of the type series. The most distinctive superficial characteristics of *N. georgiana* are the larger size in all specimens examined and more uniform and darker brown upper wing surfaces than any specimens of *N. finetaria* examined.

Examination of the genitalia of the Texas male (C. V. Covell preparation #1169) and other presumed *N. finetaria* reveals a distinct thumb-like process at about midpoint along the ventral margin of the valvula of the valve (Fig. 10), where only a slight indentation occurs in *N. georgiana*. The sacculi of the two species also differ: that of *finetaria* is distinctly more narrow than that of *georgiana*. In the female genitalia, the posterior margin of the sterigma in *N. finetaria* is not notably notched, and lacks the pair of posteriorly directed protuberances characteristic of *N. georgiana*.

In the other North American *Narraga* species, *N. stalachtaria* Strecker 1878 (type locality, Rio Navajo, Colo.), the wing coloration is almost entirely yellowish, with brown usually restricted to the upper part of the terminal area of the forewing, and along outer margin of the hindwing. The male genitalia are similar to those of *N. finetaria*, but the valvula seems to have a more narrow thumb-like process, and the sacculus is more rectangular, with dorsal and ventral margins more nearly parallel. The female genitalia appear much like those of *N. finetaria* in the limited material studied.



- Fig. 1. *Narraga georgiana*, n. sp., paratype male, upperside.
 Fig. 2. *N. georgiana*, n. sp., paratype male, underside.
 Fig. 3. *N. georgiana*, n. sp., paratype female, upperside.
 Fig. 4. *N. georgiana*, n. sp., paratype female, underside.
 Fig. 5. *N. georgiana*, n. sp., ova on leaf of shrub goldenrod, *Chrysoma pauciflosculosa* (Michx.) Greene.
 Fig. 6. *N. georgiana*, n. sp., fifth instar larva on leaf of shrub goldenrod.
 Fig. 7. *N. georgiana*, n. sp., pupae.
 Fig. 8. Habitat of *N. georgiana*, n. sp., Ochoopee Dunes, Tattnall Co., GA, Sept. 11, 1981. Note foodplant, shrub goldenrod, in bloom (center).

N. georgiana is known only from the type locality and a similar habitat 5 miles north in Emanuel Co., GA. *N. fimetaria* is known to occur in Texas, Kansas, Iowa, Arizona, Colorado, Utah, Nevada, Montana, Idaho and California. *N. stalachtaria* is known from New Mexico, Colorado, Wyoming and Oregon. *N. georgiana* appears to be double-brooded (as is *N. fasciolaria* in Europe), with adults flying in April and mid-July to mid-September. Known flight dates for *N. fimetaria* are May and late June to the end of August; those for *N. stalachtaria* include May, June and August. The meager locality and temporal data on hand at this time make firm statements regarding range and flight dates of the two western species risky. However, preliminary evidence would seem to indicate that all three species are at least bivoltine.

Life History

On 6 September 1981, individuals of *N. georgiana* at Ohoopsee Dunes were observed in close association with a flowering shrub later identified as shrub goldenrod, *Chrysoma pauciflosculosa* (Michx.) Greene (Compositae). Although not seen ovipositing on foliage of this plant, the moths flew close by concentrations of it, and were not found where the plant was absent. Live female moths and cuttings from shrub goldenrod were taken to Atlanta, where oviposition on the leaves was observed over the next 3 days. Ova were most commonly placed in chains along the leaf margins (Fig. 5), less often singly in the middle of either the dorsal or ventral leaf surface. The ova are oblong, dorsoventrally flattened, about 0.8 mm in length. They appear grayish green with a silvery sheen, and the surface appears smooth with a slanted grid pattern faintly discernible under 40X magnification. After 3 days the eggs darken, and eclosion occurs on the 6th or 7th day.

There are 5 larval instars. The caterpillars are about 2 mm in length upon hatching and about 5 mm at the first ecdysis, and are blackish and hair-thin at this stage. They will accept both young and older leaves of shrub goldenrod immediately, eating patches in the upper epidermis. Molting to the 2nd instar occurs after 5-6 days. The color of the 2nd instar is dull medium to dark green with a smooth surface. When not feeding or moving about, the caterpillars stand erect at about a 30°-40° angle from the foodplant surface, closely resembling young leaves. Molting to the 3rd instar occurs at 12 days after eclosion, when the larvae are about 8 mm long. Color in this instar becomes more bluish green than in the 2nd instar, but similarity to the foodplant color is still close. In this instar the caterpillars begin to feed inward from the edges of the leaves, consuming the whole thickness of leaf material. Molting to the 4th instar occurs at the 18th day after eclosion, and the larvae are from 12 to 14 mm long and about 1.5 mm wide. The color is still a uniform green, but paler than in the 3rd instar. Grainy, irregular, yellowish green longitudinal striations are now

apparent. After 23 days the larvae molt to the 5th instar (Fig. 6), and achieve a maximum length of 23-24 mm by the 28th day. Color is still green in this instar with the yellowish striations increasingly wider and more pronounced as the larvae age. A wider, irregular yellowish lateral line may be present. The color and mottling of the larvae are very similar to those of the foodplant, providing excellent camouflage.

On the 30th day after eclosion, larvae began leaving the foodplant and wandered for 4-5 hours about the container in which they were confined. As they wandered they began to shorten and widen, eventually becoming quiescent, having shortened in length to 10 mm—less than half their maximum length of 24 mm. These prepupae also became increasingly mottled with bluish and brown, and the yellowish striations disappeared. Some burrowed into the sand at the bottom of the container, while others became quiescent without burrowing. Those that burrowed made a loose cocoon of sand cemented with silk. Pupation occurred between 24 and 36 hours after the larvae became quiescent.

The pupa (Fig. 7) is green at first, but soon becomes dark brown. Length is 8 mm, with a 0.25 mm cremaster. Emergence of the first imago was on the 21st day after pupation; most of the others emerged on the 23rd day. Reared adults averaged slightly smaller than wild-caught specimens, and also emerged between 30 October and 6 November 1981, when conditions outdoors would be inappropriate for adult activity. We believe that in nature the late-summer generation overwinters in the pupa stage, and is normally on the wing in April. While 83 larvae entered the 5th instar, only 19 pupated; and of these only 8 emerged as adults (5 of them deformed). This poor survivorship was probably due to the fact that the foodplant used for this rearing was collected along with the parent females, and was kept in a refrigerator during the entire life cycle, and was increasingly poor in quality as time passed. On 13 April 1982 more specimens were collected at the original site, and also at another habitat in Emanuel Co., GA, 5 miles north of the other locality. Four females from the Tattnall Co. site were kept alive and taken along with living plants back to Atlanta, where the plants were placed in pots, and the females confined for oviposition. They lived for 7-8 days, and deposited 135 ova on detached leaves. This time the leaves with ova attached were pinned to leaves on the potted foodplants, and the plants were placed outdoors in a screened enclosure. In contrast to the gestation period for the late summer ova kept indoors the previous season, with hatching 6-7 days after oviposition, the April ova eclosed between the 9th and 17th days. Other details of the life history were as described above, but with the spring rearing, mortality rate in the 5th instar was considerably reduced over that experienced in late 1981 (probably because of the living foodplants). At least 81 larvae in the second rearing pupated, and 63 adults emerged between June and October. These adults were comparable in size to wild-caught individuals,

and few were deformed, testifying to better rearing conditions than in the fall 1981 group.

On 27 August 1982 a full-grown larva of *N. georgiana* was found eating foliage of shrub goldenrod at Ohoopee Dunes, confirming that plant species as a natural foodplant of the moth. The larva was reared to the adult stage in captivity. Known foodplants for other *Narraga* species include other Compositae only: *Artemisia campestris* L. for the Eurasian type species, *N. fasciolaria* (Hufnagel) (Prout in Seitz, 1912), and *Gutierrezia dracunculoides* (DC.) Blake for a Bell Co., Texas, specimen of *N. fimetaria* (Grote & Robinson) (data from specimen in U.S. National Museum).

Ecological Notes

The type locality of *Narraga georgiana* is a unique area of elliptical sand dunes that are thought to be of Pleistocene origin (Wharton, 1978), located along the Ohoopee River in Tattnall Co., GA. It can be reached by leaving Rt. US 1 at Lyons and proceeding northeast on GA Hwy. 152 to a point ¼ mile east of the Ohoopee River crossing. There one follows an unmarked dirt road that runs diagonally to the left, and takes the first dirt road on the left from that one. The first *N. georgiana* were seen between 500 and 700 yards from that intersection.

The habitat (Fig. 5) of "deep coarse sands" supports the following vegetation: ground cover of British soldier lichens; herbaceous plants such as sand spikemoss, nailwort, sand chickweed and *Balduina angustifolia* (Pursh); shrubs such as rosemary, red basil, blue flowering woody mint, jointweed and shrub goldenrod; and dwarfed trees, dominantly longleaf pine and turkey oak (Wharton, 1978).

The moths were observed flying only in open areas in bright sunlight between 10:30 AM and noon, virtually disappearing after noon as temperatures rise. Most moths stayed within 18 inches of the ground, and exhibited slow but erratic flight. They alight abruptly with wings folded together over the back, resting on twigs, blades of grass or other vegetation. No individuals were found in a search of nearby wooded areas. They remained close to patches of their foodplant, and diminished in numbers as foodplant individuals became more sparse. As no night collecting was attempted, it is not known if *N. georgiana* will come to lights.

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material in that museum; and Dr. Tim L. McCabe, N. Y. State Museum, Albany, for lending material.

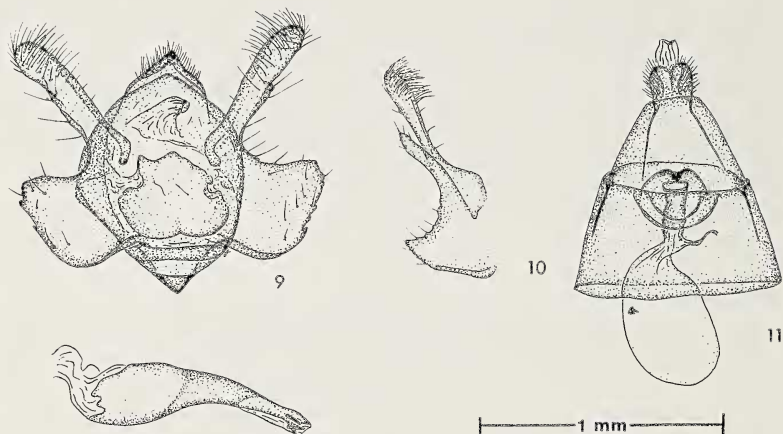


Fig. 9. *N. georgiana*, n. sp., male genitalia.

Fig. 10. *N. fimetaria* (Grt. & Rob.), left valve of male genitalia.

Fig. 11. *N. georgiana*, n. sp., female genitalia.

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